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THE HYPERVELOCITY EML PROGRAM



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Abstract: The briefing included a description of the capabilities of hypervelocity guns, potential missions for HVGs, recent HVG TMD studies, D-2 projectiles, and technology support.

Descriptors, Keywords: hypervelocity gun EML electromagnetic launcher TMD D-2 projectile technology support FY92 budget dead zone high acceleration marginal cost ammunition midcourse defense

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OUTLINE

- **UNIQUE CAPABILITIES OF HVG**
- **POTENTIAL MISSIONS FOR HVG SYSTEMS**
 - **NATIONAL ASSET DEFENSE**
 - **TMD APPLICATIONS**
- **RECENT HVG TMD STUDIES**
 - **IAT PANEL (Summer 1991)**
 - **POET ADVANCED TECH STUDY FOR TMD (Summer 1991)**
- **HVG TMD TECHNOLOGY DEVELOPMENT SCHEDULE**
- **D-2 PROJECTILE**
- **EGLIN EM GUN PROGRAM**
- **SDIO/TN HVG TECHNOLOGY SUPPORT**
- **HVG FY92 BUDGET**



UNIQUE CAPABILITIES / FEATURES OF HVG

- **Very High Acceleration and Minimum Dead-Zone**
--- especially helpful for close-in defense
- **Potential for Low Marginal Cost/Round**
--- offers system cost reduction if shots/gun $> x$
- **Practicality of Quickly Switching "Loads"**
(Different Projectiles)
--- useful in multi-threat scenarios
- **Reduced Weight and Volume of "Ammunition"**
--- wt/vol of HVG with reloads could be $<<$ wt/vol of missile launcher with reloads if shots/gun $> y$
- **Potential for Very High Velocities with Very High Acceleration**
--- crucial attribute for surface-based boost phase intercept



POTENTIAL MISSIONS FOR HVG SYSTEMS

NATIONAL MISSIONS

- ASSET DEFENSE (Near Term)
- EARLY MIDCOURSE DEFENSE (Mid Term)
- GUN LAUNCH TO SPACE (Far Term)

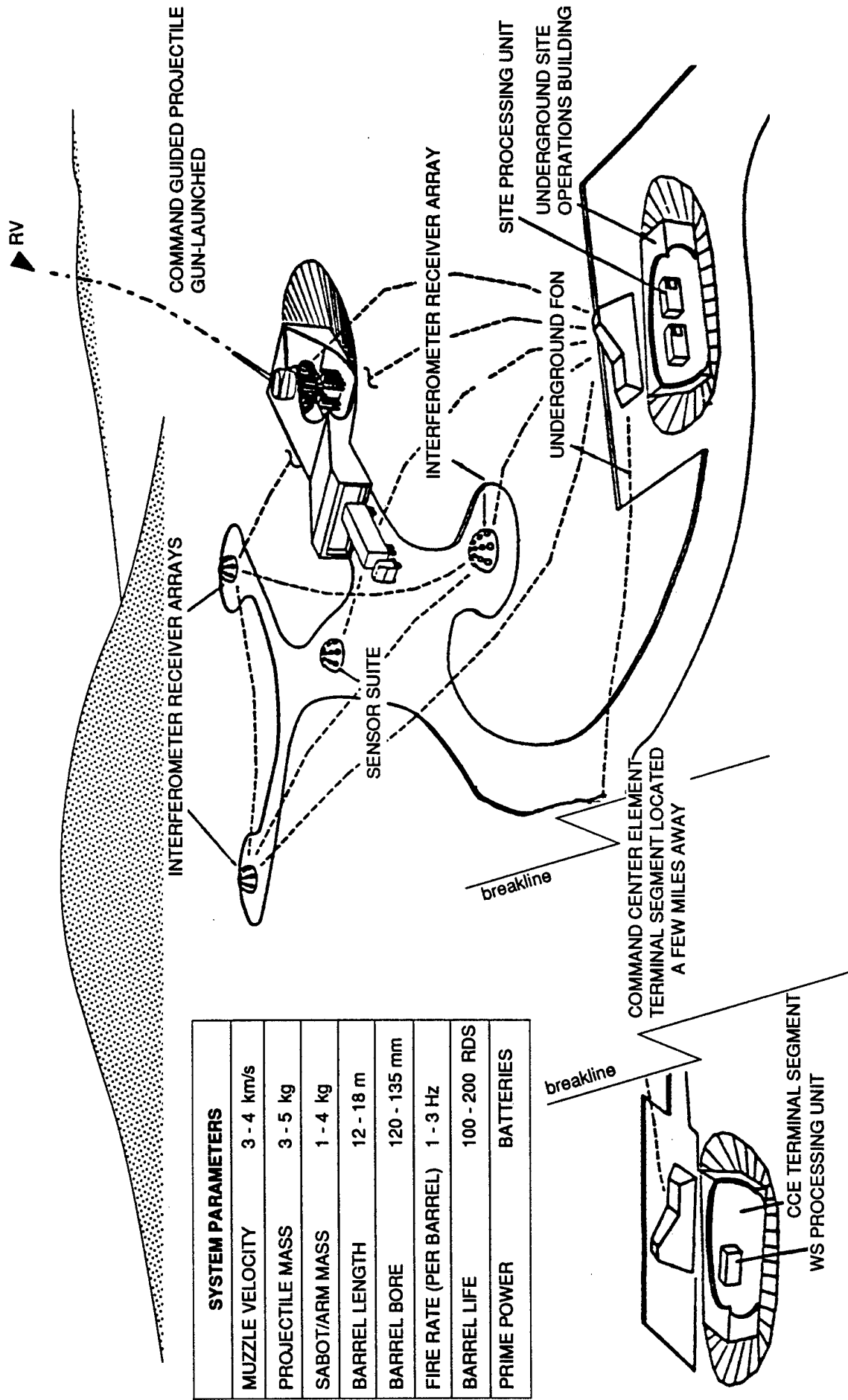
TMD MISSIONS

- THIRD TIER UNDERLAY (Near Term)
- SPECIFIED ASSET DEFENSE (Near Term)
- SUBMUNITION INTERCEPT (Near Term)
- BOOST PHASE INTERCEPT (Mid Term)

All Missions use same basic HVG Tech Base



NATIONAL MISSION CONCEPT OF OPERATION FOR HVL (ASSET DEFENSE - CONUS)





HVG APPLICATION TO TMD

NEAR TERM

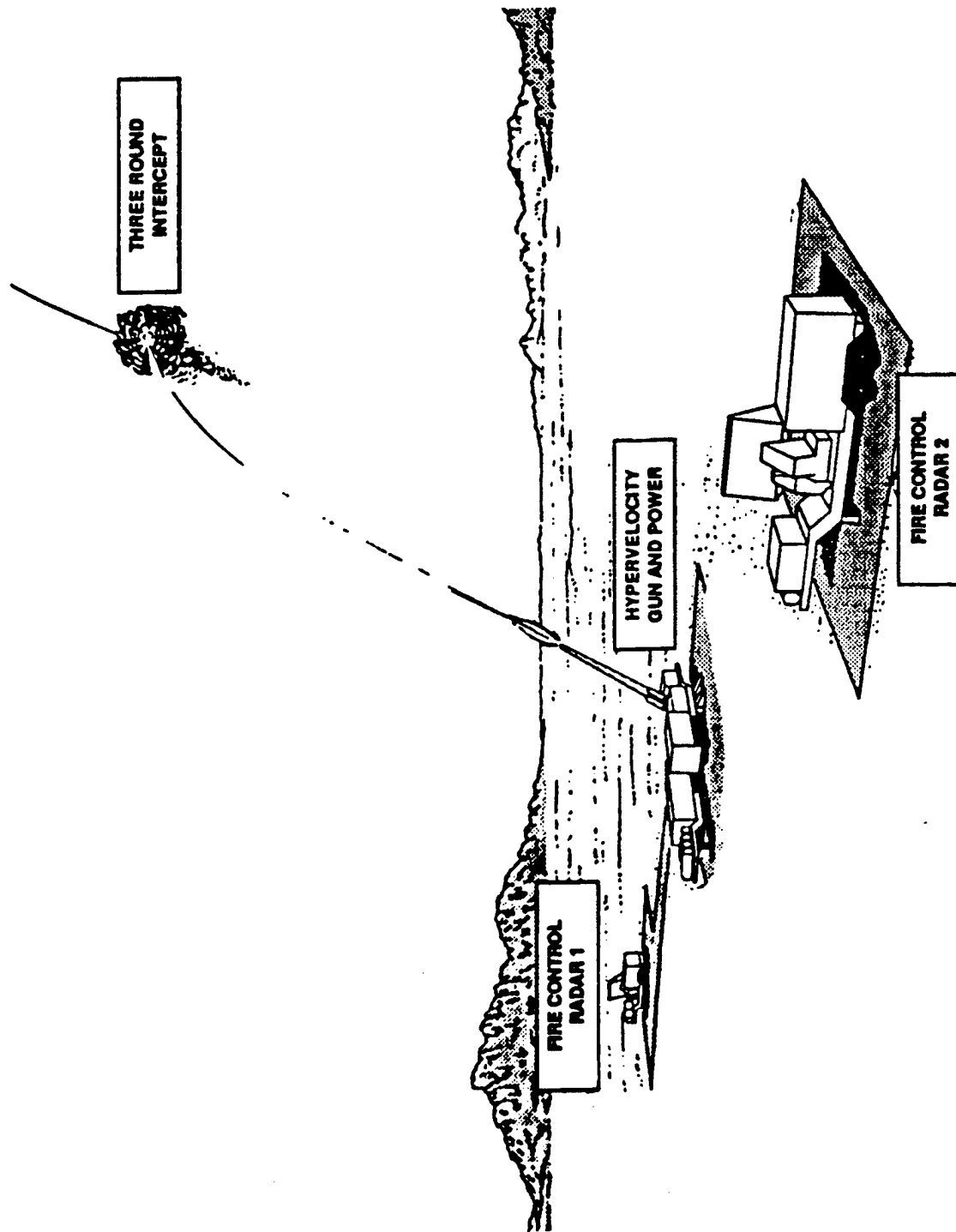
- **Close-in defenses of high value targets against TBMs / ICBMs**
 - exploit high acceleration, small dead zone
- **Defense of high value assets against proliferated multiple threats**
 - reduce cost, weight, volume of defense
(cost/weight/volume per shot, switch "loads" per gun)

FAR TERM

- **Intercept in boost phase from surface or air platforms**
 - exploit very high velocity potential



TMD MISSION CONCEPT OF OPERATION FOR HVL (CLOSE-IN ASSET DEFENSE)





INSTITUTE FOR ADVANCED TECHNOLOGY PANEL STUDY



HYPERVELOCITY GUN TECHNOLOGY FOR THEATER MISSILE DEFENSE

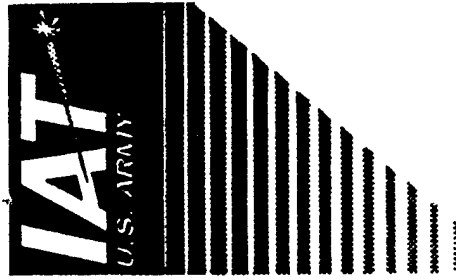
ANNOTATED BRIEFING

to

**MG O'Neill
Deputy Director, SDIO**

Austin, Texas

1 August 1991



EXECUTIVE SUMMARY

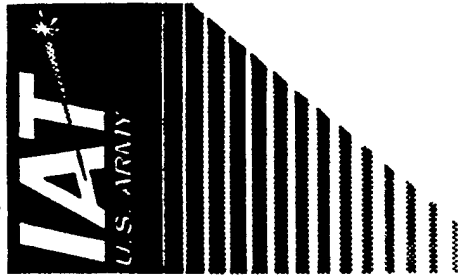


- Hypervelocity guns could play a significant role in Theater Missile Defense as a terminal underplay for high confidence protection of critical assets.
- It is premature to commit today to a DEMVAL of a Hypervelocity Gun in the Theater Missile Defense role.
- A revised four-year focused technology program is recommended to mature the technologies to support a system DEMVAL decision.

FOCUSED TECHNOLOGY PROGRAM

Current Technology Status	FY 92	93	94	95	Pre-DEMVAL Objective	Estimated Operational Needs
Power	SDI Batteries 2 MA 50MJ stored in inductor	Laboratory battery power supply	190 MJ stored in inductor 18 MJ muzzle energy	Design transportable power source	3	Volume 30 m ³ Weight 30 Tonnes 40 MJ KE Burst 3rds in 10sec. 10 secs. between bursts
Launchers	Army 3 KJ/kg 1000 kw/kg 3 MA 9 MJ KE	Develop component technology for mobile power sources	Rotating machines Integrated pulse forming networks	10KJ/kg 2000 kw/kg 20 MJ KE	2, 4	40-50 MJ muzzle energy 8m length
Fire Control	SDI 0.3 kg at 4 km/s; 3 MJ Army 2kg 3km/s; 9 MJ 1 shot	2 kg 3km/sec. 3 shots in 10 sec.	18 MJ 3km/s single shot	Thermal management repetitive shots	5	
Projectile	Radar H-T-K Accuracy to 5km Guide to basket to 25 km	Evaluate Fire Control/Projectile Guidance Trade	D2 Seeker mod Precision Radar		1	D2-like to 100 KGee 5-10kg 3-4 km/s
Tech Base	SDI Electronic & Propulsion Comp. to 100 KGee Army Slugs & Sabot	D2 Refine D2 concept	D2-like 4kg to 3km/s (100 KGee)	SLEKE unguided 9MJ-12MJ KE Armatures, Rail life, Sabot, materials		
Integration Test & Mgt.						
System Concepts		Define tactical system concept, design, cost and performance			6	

Pre-DEMVAL → DEMVAL



VII. FOCUSED TECHNOLOGY PROGRAM (\$M)



Current Technology Status	FY	92	93	94	95
Power		5	2	1	3
Launchers		5	3.5	2	1.5
Projectile		15	20	20	15
Fire Control		3	X	X	X
Tech Base		5	5	5	5
Integration Test & Mgt.		4	4	4	5
System Concepts		1	1	1	3
Boost Phase Tech Base		5	5	5	5
TOTAL		43	40.5+X	38+X	37.5+X



X. RECOMMENDATIONS



- ▶ **SDIO focus the centrally directed HVG technology development program with stable, predictable funding.**
- ▶ **SDIO and Army conduct a coordinated, synchronized, mutually-dependent program:**
 - SDIO continues laboratory power and 18 MJ single shot launcher facility
 - SDIO leads development of projectile and fire control
 - Army leads mobile power supply and repetitive high-efficiency launcher development
- ▶ **This plan be approved, funded, and executed.**

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Theater Missile Defense Advanced Technology Study

Final Review

September 4, 1991

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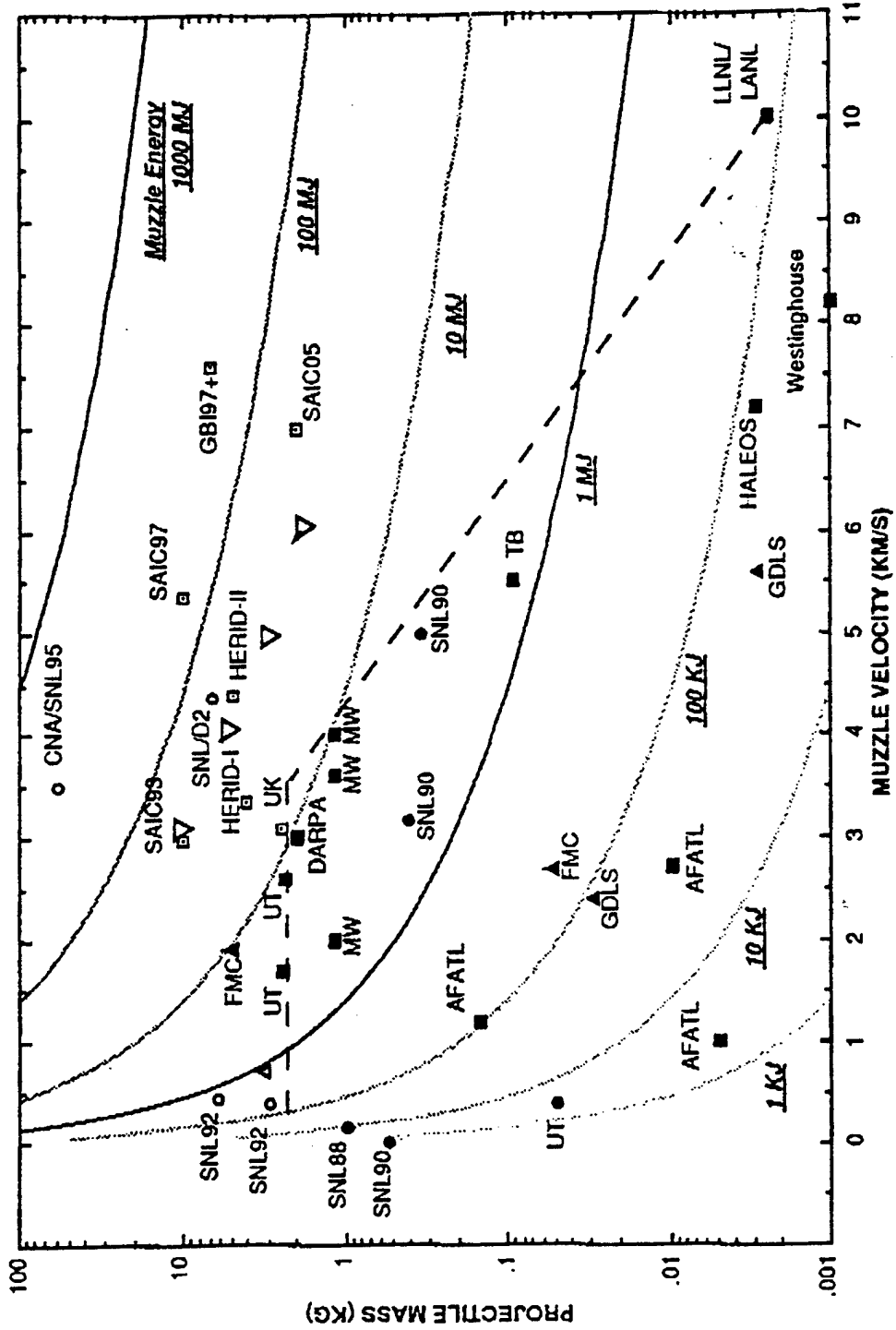
Hypervelocity Gun Maturity Roadmap (U)

with demonstrated and proposed capabilities



ET gun ▲
Railgun ■
Coilgun ●
Gas gun ▼

proposed
demonstrated



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HVG&P - Findings

Ground based a promising approach if deployed at high value targets

- Use in terminal mode for defense of high value targets
- Use in midcourse mode for defense of wider area

Emphasize

- Fire control
- Deployability

Initiate TMD-only Concept Definition study



TMD Advanced Technology Availability

Technology	Near-term (~2000)	Mid-term (~2005)	Far-term (~2010)
High power laser - Airborne - Space based		Boost phase intercept	Boost phase Intercept
Neutral particle beam - Space based			Midcourse discrimination
Hyper-velocity guns and guided projectiles - Ground based - Airborne - Space based		Cluster kill and high value target defense	Boost phase Intercept Boost phase Intercept
Laser radars - Airborne - Space based	Tracking, discriminating & designating	BE upgrade	

TMD Technology Focus

Keep Options Open



TMD Advanced Technology Review: Findings/Actions

- ABL offers greatest potential for boost phase intercept
- Propagation and lethality major uncertainties
- Cost, packaging, major system trades must be done

ACTION: Emphasize P&L measurements and modeling Support concept definition studies

- HVG&P good candidate for "cheap shot" cluster kill and low endo defense of high value targets

- Fire control major uncertainty

ACTION: Focus HVG&P on cluster kill endo defense, and deployability

- Airborne LADAR can provide high quality detection and tracking to support cluster kill, fire control and discrimination

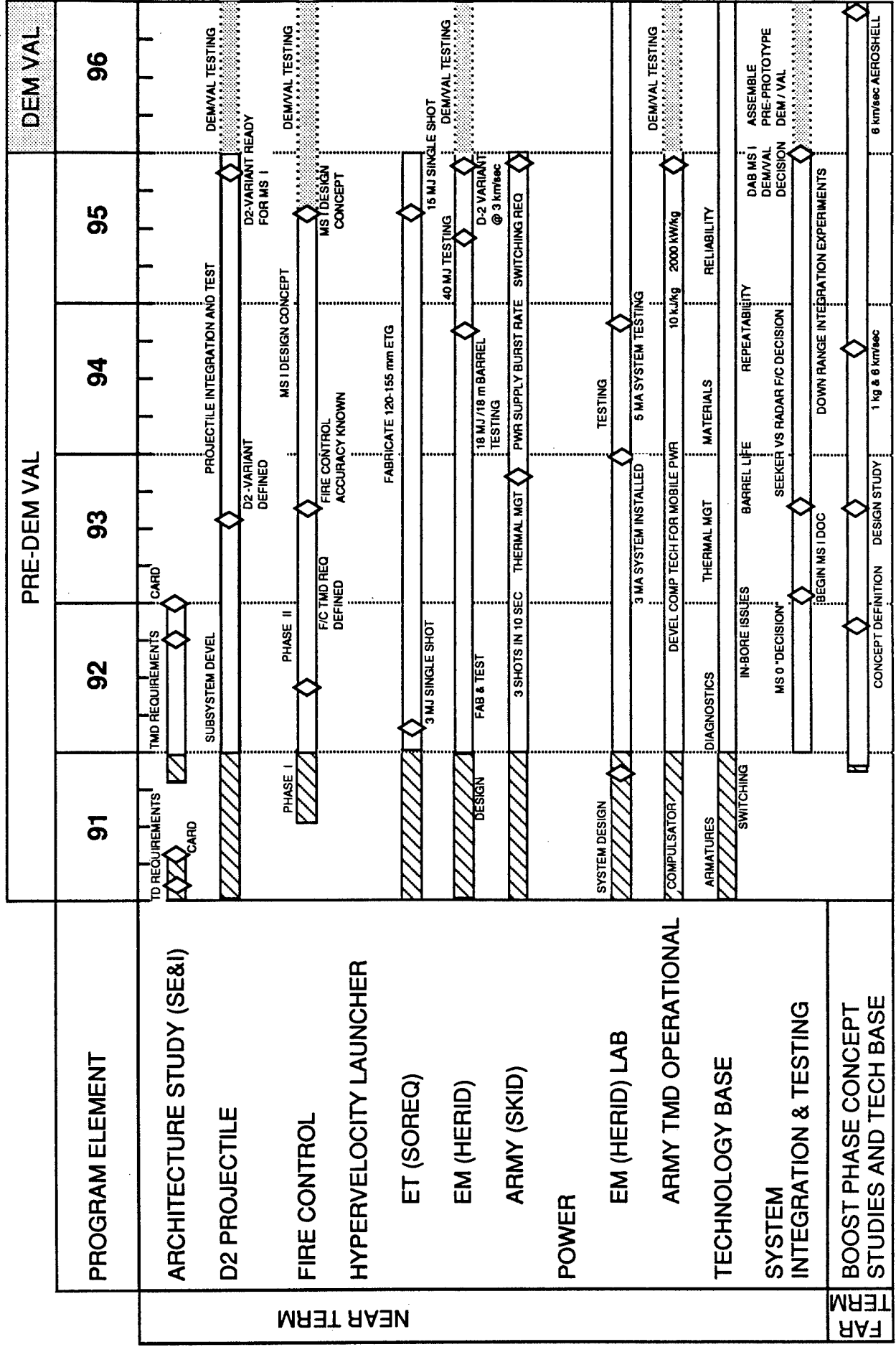
ACTION: Develop concept for implementing LADAR in TMD architecture



HVG TECHNOLOGY DEVELOPMENT SCHEDULE

(Based on FY92 Pres. Budget Funding Level of \$20M)

as of 18 Sep 91

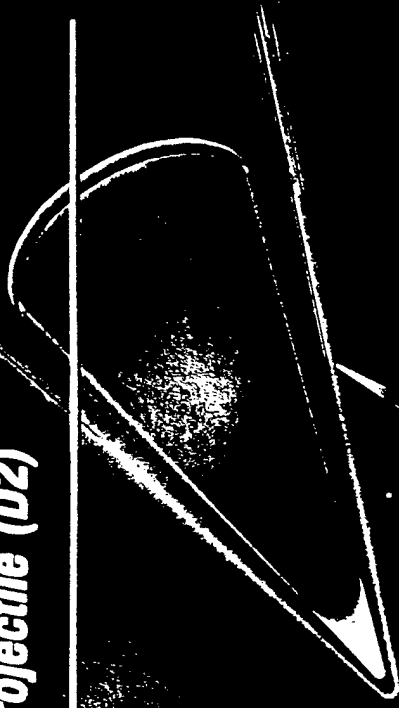


NEAR TERM

FPD TERM



Advanced Hypervelocity Launched Guided Projectile (D2)



**Terminal
Homing Phase**

**Command Guidance
Phase**

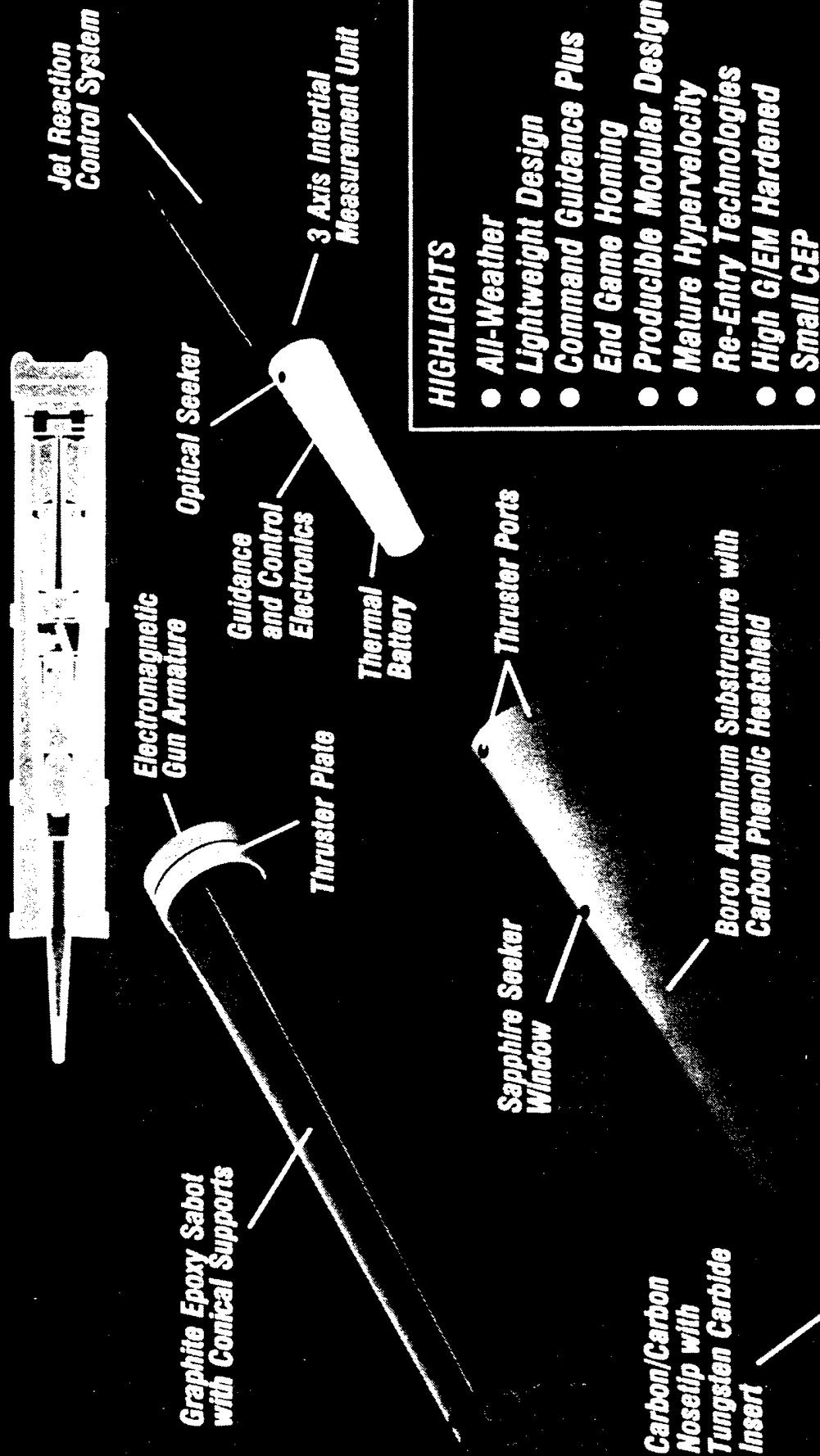
- Endo-Atmospheric Mission
- Low Cost Projectiles
- Rapid Fire Against Multiple Targets
- Highly Maneuverable Hypervelocity Flight
- Hit-to-Kill
- Follow on Technology for Theater Missile Defense

**Electromagnetic Launch
and Radar Fire Control**

Terminal Defense Against Reentry Vehicles



D2 Hypervelocity Guided Projectile



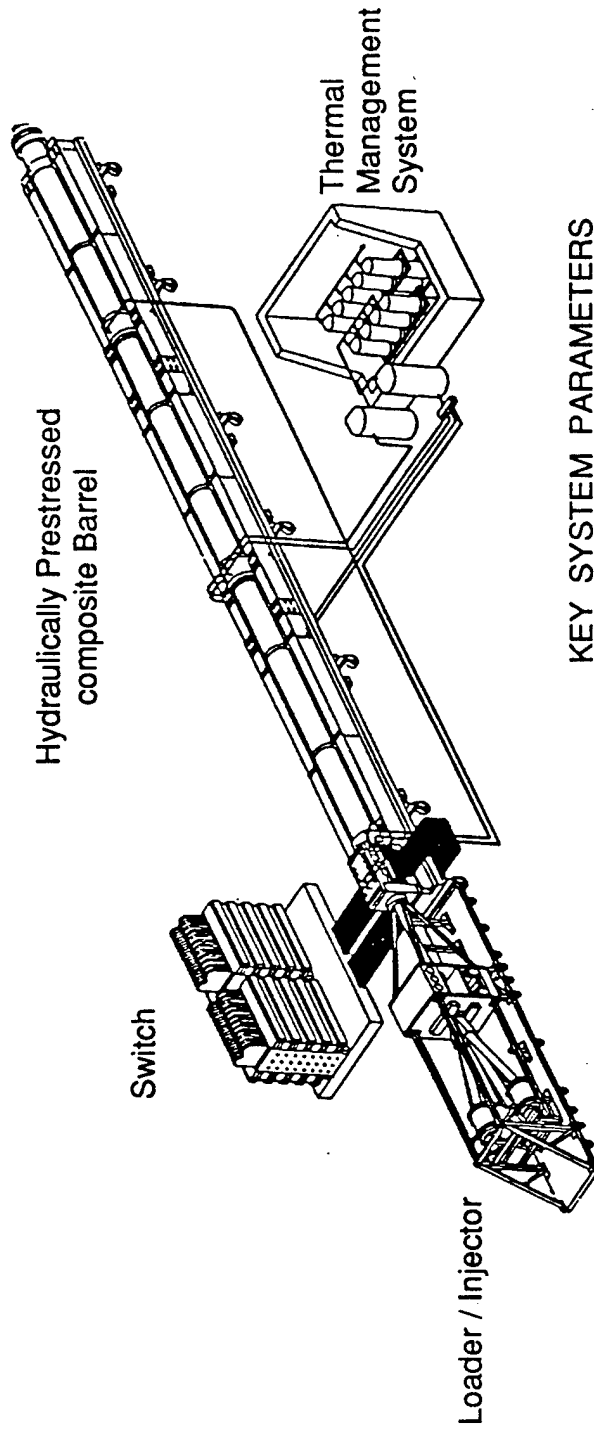
HIGHLIGHTS

- All-Weather
- Lightweight Design
- Command Guidance Plus End Game Homing
- Producible Modular Design
- Mature Hypervelocity Re-Entry Technologies
- High G/EM Hardened
- Small CEP

Agile Flight Performance and use of Composite Materials and Miniaturized Subsystems to Provide High Kinetic Kill Probability



HIGH ENERGY RAILGUN INTEGRATION DEMONSTRATION (HERID)



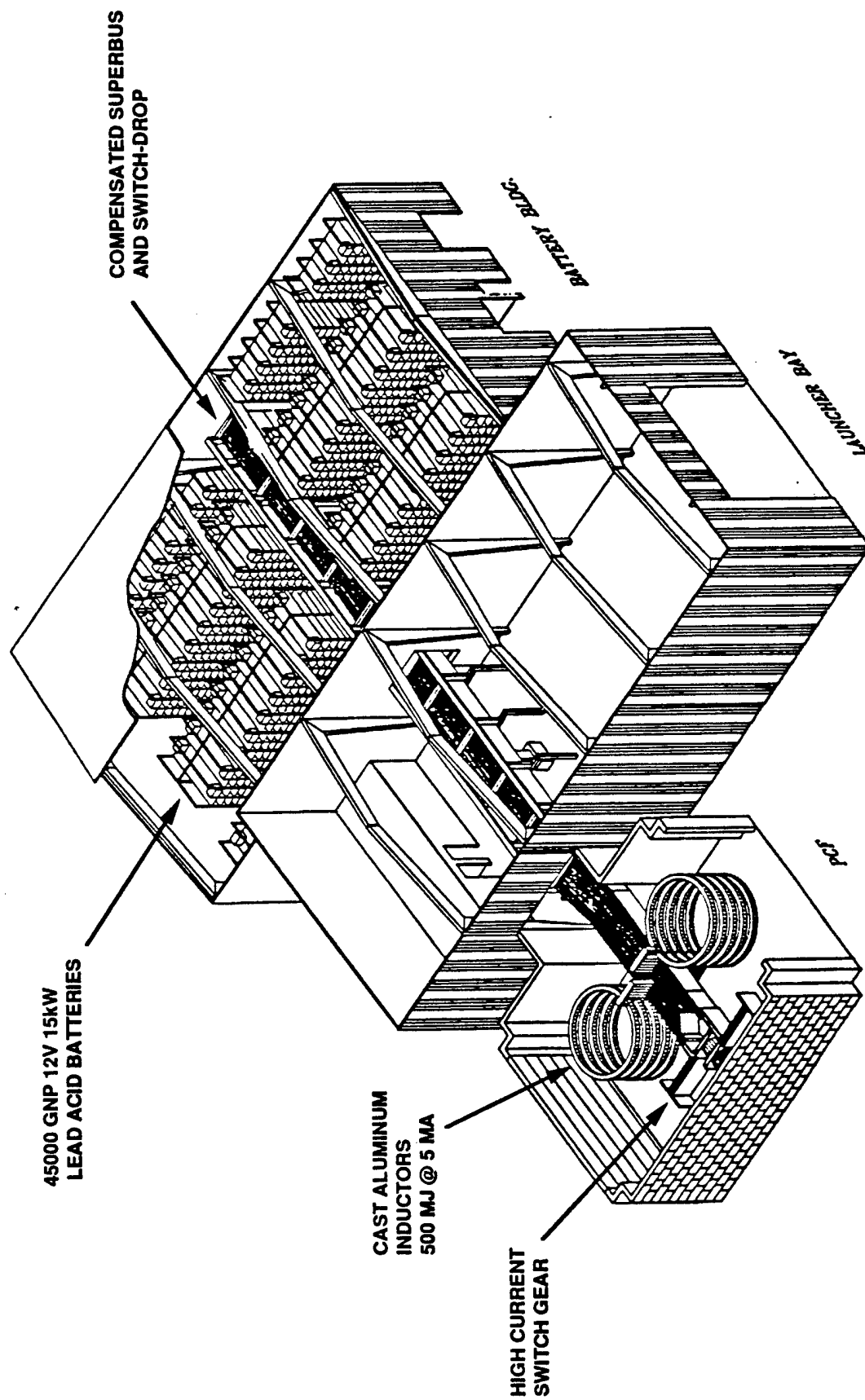
KEY SYSTEM PARAMETERS

PHASE I	
Launch Energy	> 40 MJ
Fire Rate	1 Hz
Shots per Burst	3
Peak Current	5 MA
Launch Velocity	3.6 km/s
Launch Package Mass	7 kg
Peak Acceleration	75 kgee
Injection Velocity	300 m/s

- PHASE I: 120 mm DIA x 18 m LONG



EGLIN PROPOSED BUS SYSTEM





RECENT EGLIN ACCOMPLISHMENTS

GUN	MASS (kg)	I (ma)	V (km/sec)	SHOTS
CHECMATE (50mmx5m)	.093	1.7	4.2	SS
CHECMATE (50mmx5m)	.135	1.3	1.8 - 2.1	2 SHOTS AT 5 HZ
HEB (90mmx10m)	2.400	1.6	1.4	SS
MARK IV (15mmx1m)	.005	0.8	1.0	30 SHOTS AT 5 HZ



PMA 1203 FY 92 BUDGET

TASK	PRES. BUDGET REQUEST (\$M)	IAT PANEL FUNDING LEVEL (\$M)
<u>ARMY</u>		
A1203 (1) HVG TMD CONCEPTS	0.0 FUNDED BY SDIO/TD	0.0 FUNDED BY SDIO/TD
A1203 (2) D-2 PROJECTILE	10.0 FITS HOT FIRE YAW, SPGG FAB & TEST, 50% ELEC, BB STRUC TEST, TEST PROTO SEEKER, IMU PROCR	17.5 FULL FITS, PROTO TANKS, 100% ELEC (BB DESIGN), PROTO IMU FY93, PROTO STRUC TEST, PROTO SKR
A1203 (3) FIRE CONTROL	0.0 FUNDED BY SDIO/TD	4.0 STATIC ACCURACY FIELD TEST
<u>AIR FORCE</u>		
F1203 (1) HV FACILITIES - 18/40 MJ batt upgrade (5 MA, 500 MJ STORED SYSTEM)	5.1 40% DEVEL COMPLETE (contract needs \$6.2M min.)	8.8 80% DEVEL COMPLETE
F1203 (2) TMD TESTBED BARREL - 18/40 MJ HERID gun	2.6 40% DEVEL COMPLETE (contract needs \$4.6M min.)	6.3 80% DEVEL COMPLETE
F1203 (3) HV EXPERIMENTS - switching - diagnostics - HV research - multi-shot	0.4 SS SWITCH DEMO DELAYED DEVELOP DIAG TECHNIQUES BASIC RESEARCH SMALL BORE TESTS	2.0 SS SWITCH DEMO DEVELOP DIAG TECHNIQUES BASIC RESEARCH SMALL BORE TESTS
F1203 (4) ALLIED TECHNOLOGY	0.5 ARMATURE MODELING & TESTING	0.5 ARMATURE MODELING & TESTING
F1203 (5) BOOST PHASE TECH BASE INTEGRATION SUPPORT	0.0 OUTYEAR REQUIREMENT 1.4	2.5 BOOST PHASE TMD TECH BASE DEVEL 1.4
TOTAL (\$M)	20.0 (does not meet contract requirements - BUS, D-2, HERID schedule slips)	43.0



SDIO HVG TECHNOLOGY SUPPORT

(FY92 PRES. BUDGET)

FUNDING (\$M)

TN TASKS

TNC (6.3)

- D-2 PROJECTILE
- FIRE CONTROL
- BATTERY UPGRADE SYSTEM
- HERID LAUNCHER
- TECH BASE
- BOOST PHASE TECH
- INTEGRATION SUPPORT

TOTAL

TNI (6.1/6.2)

- EML EFFORTS (INCLUDING TBOLT)
- PROJECTILE

TOTAL

TNK (6.2)

- HVG POWER

TOTAL

TD TASKS

TDW

- HVG TMD SE&I STUDY
- SOREQ GUN
- HVG FIRE CONTROL
- D-2 PROJECTILE (TMD VARIANT)

TOTAL

Exercise 2a

10.0	0.0
0.0	5.1
5.1	2.6
2.6	0.9
0.9	0.0
0.0	1.4
1.4	20.0
20.0	0.0
4.0	6.3
2.3	6.3
6.3	0.0
5.0	0.0
1.0	1.0
3.0	5.0
5.0	1.0
1.0	10.0
10.0	5.0